Political Economy of Debt and Growth

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Abstract

We present a theory of endogenous fiscal policy and growth. Fiscal policy – debt, income tax, spending on local public goods and public investment – is determined through legislative bargaining. Economic growth depends directly on public investment, private investment in human capital and, via learning-by-doing, labor supply. The model predicts that the economy converges to a balanced growth path in which consumption, private investment, public investment, public goods provision, public debt and productivity grow at the same constant rate. The transition to the balanced growth path is characterized by what we call the shrinking government effect: public debt grows faster than GDP, provisions of public goods and infrastructure grow slower than GDP and the tax rate declines. We use the model to study the impact of austerity programs which impose a ceiling on the amount of public debt a country can issue.

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1. Introduction

The rapid deterioration of the fiscal position of many western countries in the aftermath of the great recession of 2008 has brought the spotlight on the long-term effect of public debt on the real economy. Federal debt in the U.S. and in many European countries is currently its highest level since the decade following World War II. Concerns over the growth of public debt has led in 2014 to the so-called *Fiscal Compact* in Europe, an intergovernmental treaty that tightens the budget rules previously set in the *Stability and Growth Pact* of 2012;[1] and to the *Budget Control Act* of 2011 in the U.S., which triggers across-the-board automatic cuts in spending in the absence of specified deficit reductions in the following fiscal years.[2] In this context, a few key questions have dominated the public debate: To what extent do high levels of public debt reduce the growth potential of the economy? Are austerity programs, which target debt reduction, effective in increasing growth and welfare? How should they be designed? To answer these questions we need a theory in which growth and fiscal policy are jointly determined in equilibrium.

In this paper we present a political economy theory of endogenous growth in which the government can issue debt to finance expenditures. In our theory the growth rate of the economy depends on public investment, on private investment in human capital and, because of learning-by-doing, private citizens' labor supply. Fiscal policy affects citizens' incentives in two ways: taxation distorts labor supply and investment in human capital; deficits distort the consumption/savings decision through their effect on the interest rate. Policy choices are made by a legislature consisting of elected representatives. Political conflict arises because representatives in the legislature have incentives to vote for policies that favor their own constituencies, and citizens benefit only partially from local public goods

[1] Formally, the *Treaty on Stability, Coordination and Governance in the Economic and Monetary Union.*

[2] The *Bipartisan Budget Act* of 2013 later relaxed the sequestration caps, but it extended their imposition into 2022 and 2023.

provided to constituencies to which they do not belong. The level of public debt and the level of productivity in the economy are state variables and create a dynamic linkage across policymaking periods.

We start our analysis by characterizing the conditions under which the economy converges to a balanced growth path in which consumption, private investment, public investment, public goods provision, public debt and productivity grow at the same constant rate. Two forces shape the debt-to-GDP ratio on the balanced growth path: first, the political distortions, pushing politicians to increase debt to finance politically motivated transfers today; second, policy makers' desire to keep the equilibrium interest rate low, leading them to moderate the growth of debt. While both forces have been previously independently studied in the literature, our work is the first to provide a theoretical framework that combines them as building blocks for an equilibrium theory of public debt and growth.

The transition to the balanced growth path is characterized by a novel effect that we call the *shrinking government effect*: starting from a low level, public debt grows faster than GDP, provision of public goods and infrastructure grows slower than GDP and the tax rate declines. Effectively, as the economy converges to its balanced growth path, a decreasing share of output is devoted to providing public services. The shrinking government effect is a consequence of the political distortion and its effect on the interest rate. Political distortions induce the ruling coalition–the coalition in the legislature that controls fiscal policy–to use debt to shift the burden of taxation to the future. The ruling coalition trades off an extra increase in public goods today for their own districts, with a more than proportional reduction in public goods in the following period for all districts. The former option is always more appealing because the ruling coalition can better target current expenditures to their own districts rather than the future expenditure. Consequently, debt increases, forcing legislators to increase the primary surplus to service its cost. The key novel observation is that legislators find it optimal to do this by reducing expenditures rather than increasing

taxes: When expenditures are reduced, disposable income and savings increase, and so the interest rate is held down. To the contrary, when taxes are increased, disposable income and savings decline, so the interest rate goes up.

Next, we employ our model to study the effects of simple but plausible austerity programs on the economy. An austerity program is characterized by two features, a target level for debt and a time horizon: the country is required to bring down debt to a given target level in a given number of years. We find that austerity programs typically increase welfare if they are not excessively ambitious. Interestingly and perhaps counterintuitively the austerity program is not beneficial because it reduces taxes and spending. Conversely, by forcing debt to go down, the austerity program reduces the government incentives to bias the policy in favor of tax cuts and reduction in public goods provision and investment. Effectively, the austerity program reverses the shrinking government effect described above.

Three additional lessons emerge from our analysis. First, there is no "one-size-fits-all" austerity program: The optimal plan depends on the fundamentals and on the initial state of the economy. The higher is the accumulated level of debt, the less aggressive the programs should be, both in terms of the debt target and in terms of its duration. Second, on the transition path of the optimal austerity program, growth is below the pre-austerity level, but welfare is increasing. Finally, long-term commitment power is important for the program's success. Without it, debt reduction imposes an additional burden of immediate taxation which does not outweigh future benefits of lower debt, as those are only temporary.

Our paper is related to three strands of literature. First, the literature on endogenous growth (Rebelo [1990], King and Rebelo [1991], Stokey and Rebelo [1993], Jaimovich and Rebelo [2013], among others). A common trait of these normative theories is that fiscal policy is assumed to balance the budget in every period and so public debt is ruled out by assumption. Our paper contributes to this literature in two ways. First, by introducing debt we allow for a richer policy space. Second, we offer an explicit dynamic model of

political decision making in which rational forward looking policymakers bargain for the policy outcome. Positive theories of growth have been presented to study the political economy of redistribution. These papers study how income inequality determines tax policy and therefore growth (Bertola [1993], Perotti [1993], Saint-Paul and Verdier [1993], Alesina and Rodrik [1994], Krusell and Rios-Rull [1999], among others). In our paper, the target of interest is the overall efficiency of fiscal policy, not its redistributive properties.

The second strand is the literature on the political economy of public debt (e.g., Persson and Svensson [1989], Alesina and Tabellini [1990], Battaglini and Coate [2008]). These positive models do not allow for growth and make assumptions that simplify the determination of the equilibrium interest rate. These two issues are intimately connected. The key assumption in this literature is that preferences are quasi-linear: in this case the equilibrium interest rate is constant and independent of the chosen policies.[3] Balanced growth, however, is not consistent with these preferences. This is why modelling endogenous growth requires endogenous interest rates. As we show in this paper, the endogeneity of interest rates is crucial to understanding the dynamics of fiscal policy in closed economies. A neoclassical growth model in which the government can expropriate capital in the presence of political economy frictions is presented by Aguiar and Amador [2011, 2012]. Differently from our work, this research focuses on the case of a small open economy for which the interest rate is exogenous: because of this it does not study the interaction between fiscal policy, interest rates and political distortions that is the primary objective of our work.

Finally, there is a significant literature studying the political economy of deficit reduction programs both theoretically and empirically.[4] None of the papers explicitly studies the link

[3] Normative models with a benevolent planner of the strategic interaction between fiscal policy and interest rates has been first been studied by Stokey and Lucas [1983] and then extended to a variety of environments by, among others, Martin [2009] who allows for the presence of money and Occhino [2012] and Debortoli and Nunes [2013] who allow for endogenous public spending, and Aiyagari et al [2002] who consider stochastic economies.

[4] The effects of a balanced budget rule has been studied by Azzimonti, Battaglini and Coate [2011]. Among empirical contributions in this literature we have Alesina, Perotti and Tavares [1998], Ardagna [2004].

between debt, fiscal policy and endogenous growth.

The rest of the paper is organized as follows. Section 2 presents the model and Section 3 describes the political equilibrium. Section 4 presents numerical simulations. Section 5 studies the effects of austerity programs on welfare and growth. Section 6 concludes.

2. Model

A continuum of infinitely-lived citizens live in n identical districts indexed by $i = 1, ..., n$. The size of the population in each district is normalized to be one. There is a single non-storable consumption good, denoted by C, that is produced using a single factor, labor, denoted by l. There are n local public goods, denoted by $\gamma = \{\gamma^i\}_{i=1:n}$, which are produced from the consumption good. Time t variables will be denoted with a subscript t.

The citizens enjoy the consumption good, invest into their future productivity/human capital, benefit from the local public goods and supply labor. We assume that each citizen's preferences in district i are represented by the following per period utility function:

$$u^i(C_t, l_t, \gamma_t) = \log\left(C_t(1-l_t)^\mu\right) + \omega \log\left[\left(\gamma_t^i\right)^\alpha \left(\sum_{j=1}^{n} \gamma_t^j\right)^{1-\alpha}\right], \tag{1}$$

where $\mu > 0$, $\omega > 0$ and $\alpha \in [0, 1]$. This utility function describes a situation in which district i enjoys a direct benefit from public good i, but there may also be an externality from (the sum of) public goods provided to all districts. The parameter α measures the size of this externality: the closer α is to one, the smaller are the externalities and the more γ^i benefits only the citizens in district i. Citizens discount future per period utilities at rate δ.

All local public goods are produced from the consumption good according to a linear technology with a unitary marginal rate of transformation. The consumption good at time t is produced with a linear technology $y = z_t \xi_t x$, where the product $z_t \xi_t$ determines the economy's overall labor productivity and x is the labor input. The variable z_t is interpreted as an economy wide productivity factor, which is taken by the citizens as given. In our

model it captures two sources of productivity growth: learning-by-doing externalities and public investment, $\mathcal{I}_t$ (such as expenditure on research and development, education, public infrastructure, and other productivity enhancing investment). Specifically, we assume: $z_{t+1} = \eta(\bar{l}_t)\phi\left(\frac{\mathcal{I}_t}{z_t\xi_t}\right) z_t$, where $\bar{l}_t = \frac{1}{n}\sum_{i=1}^{n} l_t^i$ is the average labor supply; and $\eta(\bar{l}_t) = \eta_0 \cdot (\bar{l}_t)^{\eta_1}$ and $\phi(\frac{\mathcal{I}_t}{z_t\xi_t}) = \phi_0 \cdot (\frac{\mathcal{I}_t}{z_t\xi_t})^{\phi_1}$ are concave increasing functions: η_i, $\phi_i > 0$ for $i = 0, 1$ and η_1, $\phi_1 < 1$. The function η describes the process of learning-by-doing: The more citizens work, the more they learn from each other and more productive they will be in the future. The function ϕ describes the benefits of public investment: The higher is public investment, the higher the next period productivity is.[5]

The variable ξ_t is the level of citizens' labor productivity/human capital. In each period, citizens endogenously determine the next period level of human capital, $\xi_{t+1} = \Delta\left(\frac{\mathcal{S}_t}{z_t\xi_t}\right)\xi_t$, by choosing private investment level $\mathcal{S}_t$, which translates into human capital growth according to an increasing concave function $\Delta(s) = \Delta_0 s^{\Delta_1}$, where $\Delta_i > 0$ for $i = 0, 1$ and $\Delta_1 < 1$.

There is a competitive labor market. Hence, the wage rate in period t is equal to $z_t\xi_t$. There is also a market in risk-free, one period bonds. Both citizens and the government have access to this market. The assets held by an agent in district i in period t are denoted a_t^i. The gross interest rate is denoted ρ_t: a dollar worth of bonds at time t yields ρ_t at time $t+1$.

For a given sequence of government policies, citizens' maximization problem in period 0 can be written as:

$$\max_{\{C_t, S_t, l_t\}} \sum_{t=0}^{\infty} \delta^t \left\{ \log\left(C_t(1-l_t)^{\mu}\right) + \omega \log\left[\left(\gamma_t^i\right)^{\alpha} \left(\sum_{j=1}^{n} \gamma_t^j \right)^{1-\alpha} \right] \right\}$$

[5] The scaling by $\frac{1}{z_t\xi_t}$ is standard to ensure that investment as a fraction of output does not shrink to zero over time: In a growing economy, the higher is productivity, the more expensive it should be in absolute terms to improve it.

$$s.t.\ \frac{a_{t+1}}{\rho_t} + C_t + \mathcal{S}_t = (1-\tau_t) z_t \xi_t l_t + a_t + \mathcal{T}_t,$$
$$\xi_{t+1} = \Delta\left(\frac{\mathcal{S}_t}{z_t \xi_t}\right)\xi_t \text{ and } z_{t+1} = \eta(\bar{l}_t)\phi\left(\frac{\mathcal{I}_t}{z_t \xi_t}\right) z_t,$$

where τ_t is the tax rate and $\mathcal{T}_t$ is the lump-sum transfers from the government.

2.1. Public Policies

The government provides local public goods, public infrastructure and can make direct lump-sum monetary transfers to the districts. Monetary transfers are uniform across districts and are interpreted as a welfare program symmetrically targeted to all regions. Revenues are raised by levying a proportional tax on labor income and can be supplemented by borrowing and lending in the bond market. Government policy in period t is described by $\{\tau_t, \beta'_t, \gamma^1_t, ..., \gamma^n_t, \mathcal{I}_t, \mathcal{T}_t\}$, where τ_t is the income tax rate; β'_t is the amount of bonds sold; γ^i_t is the amount of public good provided to district i; $\mathcal{I}_t$ is the level of infrastructure investment; and $\mathcal{T}_t$ is the uniform cash transfer. When β'_t is negative, the government is buying bonds. In each period, the government must also repay the bonds sold in the previous period, which are denoted by β_t. The government's initial debt level in period 0 is β_0; agents initial assets are $a^i_0 = a_0 = \frac{\beta_0}{n}$.

Government policies must satisfy three feasibility constraints. First, tax revenues and net borrowing must be sufficient to cover public expenditures. To see what this implies, consider a period in which the initial level of government debt is β_t and the interest rate is ρ_t. Total expenditure is $\sum_{i=1}^{n} \gamma^i_t + \mathcal{I}_t + \mathcal{T}_t + \beta_t$, tax revenue is $\tau_t z_t \xi_t \sum_{i=1}^{n} l^i_t$, and revenue from bond sales is β'_t/ρ_t. So the government budget constraint is:

$$\beta'_t - \rho_t \left[\beta_t + \sum_{i=1}^{n} \gamma^i_t + \mathcal{I}_t + \mathcal{T}_t - \tau_t z_t \xi_t \sum_{i=1}^{n} l^i_t\right] \geq 0. \tag{2}$$

Second, to keep the policy space compact in the legislator's maximization problem, we assume that local public goods, public investment and transfers as fractions of GDP can

not be smaller than some minimal levels: $\gamma_t^i/y_t \geq \underline{g}, \mathcal{I}_t/y_t \geq \underline{I}$, and $\mathcal{T}_t/y_t \geq \underline{T}$ for all i, where $\underline{g} > 0, \underline{I} > 0$, and $\underline{T} \geq 0$. The lower bound $\underline{T}$ is interpreted as commitments on transfers made by previous legislations that are not directly modelled here (e.g., Social Security, Medicare and Medicaid). Third, debt, relative to GDP, is bounded: $\beta_t/y_t \in \left[\underline{b}, \overline{b}\right]$.[6]

2.2. Market equilibrium and political decision making

We will study a symmetric equilibrium in which $a_t^i = a_t$ as well as $l_t^i = l_t, C_t^i = C_t$, and $S_t^i = S_t$ for all i's. Since for any given government policy the interest rate must clear the bond market, in such an equilibrium we have $a_t - a_{t+1}/\rho_t = \frac{1}{n}\left(\beta_t - \beta_{t+1}/\rho_t\right)$. Using (2) and households' optimality conditions with respect to labor, consumption, and private investment, we can express the citizens' choices as functions of current public policies only. It is useful to express some variables in terms of GDP. Define $g_t^i = \gamma_t^i/y_t$, $I_t = \mathcal{I}_t/y_t, T_t = \mathcal{T}_t/y_t$, and $p_t = \{\tau_t, \{g_t^i\}_{i=1:n}, I_t, T_t\}$.

We show in the Appendix that citizen i's utility can be written as a function of only current public policies and the level of overall productivity:

$$u^i(p_t, z_t, \xi_t) = (1+\omega)\log z_t\xi_t + U(p_t) + \omega \log\left[\left(g_t^i\right)^{\alpha}\left(\sum_{j=1}^{n} g_t^j\right)^{1-\alpha}\right], \tag{3}$$

where $U(p_t)$, derived in Lemma A.1 of the Appendix, can be interpreted as the indirect per period utility function, scaled by productivity $z_t\xi_t$. Note that since the evolution of the economy's overall productivity, $z\xi$, is fully described by the function $Z(p) \equiv \eta(l(p)) \cdot \phi\left(I \cdot nl(p)\right) \Delta\left(s(p)\right)$, we have that $z_{t+1}\xi_{t+1} = Z(p)z_t\xi_t$. Using this expression, the intertemporal Euler equation can we written as:

$$\rho_t^{-1} = \delta\frac{u_c(p_{t+1}, z_{t+1}, \xi_{t+1})}{u_c(p_t, z_t, \xi_t)} = \delta\frac{c(p_t)}{Z(p_t)c(p_{t+1})}. \tag{4}$$

[6] The upper bound on debt is a standard requirement ruling out Ponzi schemes. As we show later, setting the lower bound on debt to zero is without loss of generality. Since taxes are distortionary, uniform cash transfers are welfare reducing. Hence, the lower bound on the transfers is binding. Of the constraints on the local public goods, $\gamma_t^i/y_t \geq \underline{g}$, only those associated to the districts that are excluded from the coalition in charge of the policy are binding. The identity of these districts changes in every period.

From (3) it is clear that the districts are heterogeneous only with respect to the amount of local public goods they receive. These are the variables over which there is political conflict.

Government policy decisions are made by a legislature consisting of representatives from each of the n districts. One citizen from each district is selected to be that district's representative. Since all citizens have the same policy preferences, the identity of the representative is immaterial and, hence, the selection process can be ignored. The legislature meets at the beginning of each period. To describe how legislative decision-making works, suppose the legislature is meeting at the beginning of a period in which the current level of public debt is β_t. The process has two phases: government formation and bargaining in the government. In the first phase, one of the legislators is randomly selected to form a government, with each representative having an equal chance of being recognized. A government is a cabinet of $\mathcal{G}$ representatives and a policy platform $\{\beta_{t+1}, \tau_t, \Gamma_t, \mathcal{I}_t, \mathcal{T}_t\}$, where Γ_t is the aggregate amount of public goods. In the second phase, the cabinet members allocate the local public goods. The initial government formateur proposes a provisional distribution of the local public goods $\{\gamma_t^i\}_{i=1:n}$. If the first proposal is accepted by $q \leq \mathcal{G}$ cabinet members, then it is implemented and the legislature adjourns until the beginning of the next period. At that time, the legislature meets again with the difference being that the initial level of public debt is β_{t+1} and overall productivity has grown by $Z(p_t)$. If, on the other hand, the first proposal is not accepted, another member of the government is chosen to propose an alternative redistribution of $\{\gamma_t^i\}_{i=1:n}$. The process continues until a proposal is approved by the cabinet. We assume that each proposal round takes a negligible amount of time.[7]

[7] Our bargaining process gives as special cases many bargaining processes used in the political economy literature. When $\mathcal{G} = 1$ the policy is chosen by a randomly selected dictator as in Alesina and Tabellini [1990]. When $\mathcal{G} > 1$ and $q = \mathcal{G}$ the policy is chosen to maximize the aggregate utility of a coalition of size $\mathcal{G}$ as in Battaglini and Coate [2014]. When $\mathcal{G} = q = n$, the policy coincides with the utilitarian optimal policy.

3. The political equilibrium

It is useful to start by highlighting the key determinants of growth in our economy. On a balanced growth path income, consumption, and private investment, as well as public expenditure and tax revenue, grow at the same constant rate σ. It is easy to see that in our economy the growth rate of all key variables is determined by the growth rate of overall productivity: $\sigma = \frac{\Delta z}{z}\frac{\Delta \xi}{\xi}$. Hence, even before we start studying political decision making, we can see the role of fiscal policy on σ. On the balanced growth path we have $\sigma = Z(p) - 1$. The growth rate is a function of the primitives of the economy *and* of public policies. This is not in itself a new observation, since it has been long recognized that in endogenous growth models public policies have a long-term effect on the growth rate (see Rebelo [1991]). The interesting point is that, in our model, explaining fiscal policy is *necessary* to obtain an *endogenous* theory of growth.

3.1. Equilibrium behavior

We look for a symmetric Markov perfect equilibrium (SME) in which players' strategies depend only on the level of public debt scaled by productivity, i.e. $b_t = \beta_t/(z_t\xi_t)$. As we formally show below there is no loss of generality in adopting b_t as the state variable. A symmetric Markov equilibrium can be formally defined by a collection of policy functions $p(b) \equiv \{\tau(b), I(b), T(b), b'(b), g(b), g^c(b)\}$. Here $\tau(b)$, $I(b)$ and $T(b)$ are the tax rate and the share of GDP spent on public investment and transfers proposed in state b. The function $b'(b)$ is the new level of debt normalized by the future productivity, i.e. $\beta'/(z'\xi')$. The remaining two functions describe how local public goods are distributed in the economy. In a SME the proposer randomly selects $\mathcal{G}-1$ legislators to form a cabinet, choosing them from the remaining $n-1$ legislators with equal probability. The proposer provides sufficient local public goods to q cabinet members to guarantee their vote, and as little as possible to the others (in the cabinet or outside). The functions $g(b)$ and $g^c(b)$ are the shares of GDP of the

public good proposed for, respectively, the proposer's district and the other districts in the minimal winning coalition. All the other representatives excluded from the minimal winning coalition receive the minimal share of GDP possible, $\underline{g}$.

As standard in the theory of legislative voting, we focus on weakly stage undominated strategies, which implies that legislators vote for a proposal if they prefer it (weakly) to continuing on to the next proposal round. We focus, without loss of generality, on equilibria in which, at each round, proposals are immediately accepted by at least q legislators so that, on the equilibrium path, no meeting lasts more than one proposal round. We say that an equilibrium is smooth if the policy functions are continuously differentiable in b. In the reminder of the paper we study only such equilibria.

To characterize the equilibrium strategies consider the proposer's problem. She chooses the policies to maximize the utility of her own district under the budget constraint and the feasibility constraints. In addition, an incentive compatibility constraint, which guarantees that the proposal is voted by a qualified majority, must be satisfied:

$$U(p) + \omega \log \left[(g^c)^\alpha \left(\sum_{j=1}^{n} g^j \right)^{1-\alpha} \right] + \delta v(b', z', \xi') = v_{\mathcal{G}}(b, z, \xi), \tag{5}$$

where z' and ξ' are the next period productivity factor and human capital level after policy p is implemented, $v(b', z', \xi')$ is the citizens' continuation value, and $v_{\mathcal{G}}(b, z, \xi)$ is the outside option of a cabinet member. The left hand side of this constraint is the expected utility of accepting the proposal for a member of the minimal winning coalition who receives a level $g^c(b)$ of local public good. The outside option of a cabinet member, $v_{\mathcal{G}}(b, z, \xi)$, is the expected utility of voting no and therefore moving to the stage of the bargaining game in which a new government member is randomly selected.[8] The next result shows that (5) imposes a precise relationship between $g(b)$ and $g^c(b)$:

Lemma 1. *In equilibrium, the incentive compatibility constraint (5) is satisfied if and only*

[8] The incentive constraint needs to be satisfied as a weak inequality. In equilibrium, however, the proposer minimizes the cost of obtaining a minimal winning coalition, so (5) is always satisfied as an equality.

if $g^c(b) = g(b)^{Q(\mathcal{G},q)} \cdot \underline{g}^{(1-Q(\mathcal{G},q))}$, *where* $Q(\mathcal{G},q) = \frac{1}{\mathcal{G}-q+1} \in (0,1]$.

Lemma 1 shows that the bargaining process forces the proposer to provide a level of local public good to the members of the minimal winning coalition equal to a geometric average of the level he assigns to his own district and the level he assigns to the districts outside the coalition, $\underline{g}$. Total public goods expenditure is a function of $g(b)$ only: $G(b) = g(b) + (q-1)g(b)^{Q(\mathcal{G},q)}\underline{g}^{(1-Q(\mathcal{G},q))} + (n-q)\underline{g}$. It should be noted that the weight on $g(b)$ is an increasing function of q: The larger is q, the more the proposer is forced to internalize the welfare of the other government members. Indeed, when the voting rule is unanimous and so $q = \mathcal{G}$, we have $g^c = g$.[9]

As shown in Section 2, the citizens' per period indirect utility function is separable in $z\xi$ and p (see expression (3)). The value function has a similar representation. As shown in the Appendix, we can express the value function as $v(b,z,\xi) = \mathcal{A}\log z\xi + \mathcal{V}(b)$, with $\mathcal{V}(b)$ defined recursively as:

$$\mathcal{V}(b) = \mathcal{U}(p(b)) + \alpha\frac{\mathcal{G}}{n}Q(\mathcal{G},q)\omega\log g(b) + (1-\alpha)\omega\log G(b) + \delta\mathcal{V}(b'(b)), \tag{6}$$

where $\mathcal{A}$ is a constant and $\mathcal{U}(p)$ is specified in closed form in the Appendix.[10] Using Lemma 1, moreover, the proposer's problem can be written as:

$$\max_{b',\tau,g,G,I,T}\left\{\begin{array}{c} \mathcal{U}(p) + \alpha\omega\log g + (1-\alpha)\omega\log G + \delta\mathcal{V}(b') \\ s.t.\ Z(b)\frac{b'}{\rho(b,b')} - b - [G(g) + I + T - \tau]\, nl(p) = 0 \\ G = g + (q-1)g^{Q(\mathcal{G},q)} \cdot \underline{g}^{(1-Q(\mathcal{G},q))} + (n-q)\underline{g} \\ b' \leq \overline{b},\ g \geq \underline{g},\ I \geq \underline{I},\ T \geq \underline{T}, \tau \in [0,1] \end{array}\right\} \tag{7}$$

The representation in (6)-(7) highlights the role of the political process on how policies are chosen in equilibrium. When $\alpha = 0$ policies have a uniform effect on the citizens' welfare.

[9] When the government deliberates by unanimous rule (i.e. $q = \mathcal{G}$), all the government members are treated in the same way and the policy is chosen to maximize the aggregate utility of government members.

[10] The function $\mathcal{U}(p)$ can be interpreted as the indirect utility function given policy $p(b)$ from consumption and labor, augmented by the (permanent) effect of current policy $p(b)$ on future productivity. We represent the indirect utility function as in (6) to highlight the difference with the objective function of the proposer in (7), as discussed below.

In this case there is no political conflict and the proposer chooses policies to maximize the welfare of the representative citizen. When $\alpha > 0$, districts value local public goods differently. In this case the proposer overestimates the welfare effect of g. The magnitude of the overestimation depends on $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)$. When $q = \mathcal{G} = n$, we have $Q(\mathcal{G},q) = 1$ and full alignment of interest across districts is re-established. When $\mathcal{G} < n$ or $q < \mathcal{G}$ then $\frac{\mathcal{G}}{n}Q(\mathcal{G},q) < 1$ and we have political conflict.

Using (6)-(7) we have the following characterization of a political equilibrium:

Proposition 1. *(1) If $p = \{\tau, I, T, b', g, g^c\}$ solves (7) given $\mathcal{V}$, and $\mathcal{V}$ satisfies (6) given p, then p is an equilibrium policy function and $v = \mathcal{A}\log z\xi + \mathcal{V}$ is the associated equilibrium value function. (2) If $p = \{\tau, I, T, b', g, g^c\}$ is a political equilibrium with value function v, then p is a function only of b and there are a function $\mathcal{V}$ of b only and a constant $\mathcal{A}$ such that the value function can be represented as $v = \mathcal{A}\log z\xi + \mathcal{V}$. Moreover, p solves (7) given $\mathcal{V}$, and $\mathcal{V}$ satisfies (6) given p.*

The first part of Proposition 1 shows that to characterize an equilibrium we can simply study (6) and (7), where the state variable is b. Once we have solved for the fixed-point implied by these two conditions, the value function can be immediately found with the formula $v = A\log z\xi + \mathcal{V}$. The second part shows that there is no loss of generality in considering the representation (6) and (7), since all equilibria can be expressed in this way.

3.2. Balanced growth and transition dynamics

It is useful to introduce a key concept in public finance, the marginal cost of public funds (MCPF). MCPF is the compensating variation for a marginal increase in tax revenues.[11] It is, therefore, a measure of the distortion introduced by the government into the economy. Consider MCPF associated with policies $\{\tau_t^*, b_t^{*\prime}, I_t^*, T_t^*, g_t^*\}$ that would be chosen by a benevolent planner who can commit to the optimal policy plan. Under standard assumptions, the

[11] In intuitive terms, the $MCPF$ is the marginal monetary transfer necessary to compensate an agent for a marginal increase in tax revenues.

planner aims at smoothing the cost of taxation over time as much as possible. This implies that polices are chosen so that the marginal cost of public funds is equalized over time: $MCPF_t^* = MCPF_{t+1}^*$ for any $t > 0$. Constant MCPF implies that fiscal policy and the growth level of the economy are all constant for any $t > 0$. Is this result still valid in a political equilibrium? If not, what are the implications for the dynamics of the economy?

To answer these questions, let us define the elasticity of the interest rate with respect to b' evaluated at the equilibrium level $b' = b'(b)$ in state b as $\varepsilon_\rho(b) = \frac{\partial \rho(b',b)}{\partial b'} \frac{b'}{\rho(b',b)}$. Let us also define $\varepsilon_g(b)$ as the elasticity of the policy function g with respect to debt, $\varepsilon_g(b) = \frac{\partial g(b)}{\partial b} \frac{b}{g(b)}$. We have the following characterization of the evolution of MCPF in a political equilibrium:

Proposition 2. *In equilibrium:*

$$[1 - \varepsilon_\rho(b_t)]\, MCPF(b_t) = \left[1 - \alpha\omega \left[\frac{\mathcal{G}}{n} Q(\mathcal{G}, q) - 1\right] \Phi(b_{t+1})\, \varepsilon_g(b_{t+1})\right] MCPF(b_{t+1}), \quad (8)$$

where $\Phi(b)$ *is a nonnegative function of debt.*

As noted above, in the first best, we must have $MCPF(b_t) = MCPF(b_{t+1})$**.** Proposition 2 shows that in a political equilibrium this equality does not hold: there is generally a wedge between MCPF at t and at $t + 1$. Condition (8) generalizes analogous representations of the evolution of the "cost of resources" in political system that are typically referred to as modified or generalized Euler equations.

The intuition behind (8) is as follows. The left hand side is the marginal benefit of debt: by increasing debt by a unit, tax revenues can be reduced by a unit at time t, inducing a net welfare gain equal to $MCPF(b_t)$. This term is corrected by $(1 - \varepsilon_\rho(b_t))$ to account for the fact that the government is not a price taker in the bond market. When, for example $\varepsilon_\rho(b_t) > 0$, an increase in debt implies an increase in the interest rate and the corresponding reduction in resources limits the benefit of an increase in b. The right hand side can be interpreted as the marginal cost of debt. An increase in debt generates two effects: it reduces future resources (with a welfare effect measured by the term $MCPF(b_{t+1})$), and

changes the future policy mix by affecting policies (this second effect is represented by the term $\left[1-\alpha\omega\left[\frac{\mathcal{G}}{n}Q(\mathcal{G},q)-1\right]\Phi\left(b_{t+1}\right)\varepsilon_g(b_{t+1})\right]$). When policies are chosen by a utilitarian planner, the second effect is irrelevant: policies are always optimal, so by the Envelope theorem, a marginal change from the optimal level has no welfare effect. Since in our model policies are inefficient, however, the change in the policy mix induced by b has a first order impact that cannot be ignored. Naturally, the inefficient policy mix is a result of the political distortion. Not surprisingly, the size of the political distortion depends on α and $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)$: the larger is α, the more severe is political conflict because citizens internalize less the benefit of local public goods provided to districts to which they do not belong. Similarly, the smaller is $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)$, the less the ruling coalition is forced to internalize the welfare of the remaining districts. When $\alpha=0$ or $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)=1$, it is as if policies were chosen by a utilitarian decision maker, so the political distortion is zero.[12]

On a balanced growth path debt grows at the same rate as income, so b_t remains constant at b^*. We say that balanced growth path is *stable* if there is a neighborhood of b^* such that b converges to b^* for any initial state b_0 in that neighborhood. We say that a balanced growth path is *regular* if it stable and two conditions are met: (1) debt is positive on the path, i.e. $b^*>0$; and (2) the interest rate elasticity is positive on the balanced growth path: i.e., $\varepsilon_\rho(b^*)>0$ (or $\partial\rho(b',b)/\partial b'>0$ at b^*). We say that there is *political conflict* in the economy if $\alpha>0$ and $q<n$. We have:

Proposition 3. *A stable balanced growth path is regular only if there is political conflict.*

Figure1 about here

The intuition behind Proposition 3 is illustrated by Figure 1. Consider first Figure 1.A where we present an equilibrium in an environment with no political conflict (so $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)=1$

[12]We obtain an interesting interpretation of (8) by dividing both sides by $1-\varepsilon_\rho(b_t)$. The government acts as a standard monopolist: debt is chosen to equalize the marginal benefit to the marginal cost of debt weighted by a standard markup factor that depends on the elasticity of the demand: $1/\left(1-\varepsilon_\rho(b_t)\right)$.

or $\alpha = 0$). The red dotted line represents the left hand side of the previous equation, $(1 - \varepsilon_\rho(b))MCPF(b)$; the blue solid line represents the right hand side, $MCPF(b')$.[13] The level of debt corresponding to a balanced growth path is determined by the intersection of these two curves (where $MCPF(b_{t+1}) = MCPF(b_t)$). When there is no political distortion (i.e. $\alpha = 0$ and/or $\frac{\mathcal{G}}{n}Q(\mathcal{G}, q) = 1$), the only point of intersection is $b^* = 0$ (See Figure 1.A). Consider now the situation when there are political distortions. In this case, the solid blue curve corresponding to the right hand side of (8) is shifted downward since $1 - \alpha\omega\left(\frac{\mathcal{G}}{n}Q(\mathcal{G}, q) - 1\right)\Phi\left(b_{t+1}\right)\varepsilon_g(b_{t+1}) < 1$. It follows that the only point of intersection occurs at a $b^* > 0$ (See Figure 1.B), and that is where the economy converges in the long run.

It is interesting to note that the positive *interior* long-run level of debt in the model is the result of two contrasting forces: on the one hand, political economy distortions push debt up; on the other hand, the attempt to manipulate the interest rate pushes debt down. We would not have positive debt on the balanced growth path without the first effect; we would not have an interior level of debt without the second effect: politicians would always have an incentive to shift the financing of expenditure to the future and accumulate more debt. On the balanced growth path the two incentives exactly counterbalance each other.

The next two results characterize the dynamics of the public sector on the convergence path to a regular balanced growth path.

Proposition 4. *Starting from any b_0 in a left neighborhood of a balanced growth path level, both infrastructure and the expected level of local public goods grow slower than GDP.*

Proposition 4 implies that even though the policymakers have excessive incentives to spend on local public goods, the size of the public sector, relative to GDP, shrinks over time. This is a consequence of the political distortion in the presence of endogenous interest rates. Faced with a higher level of debt, the proposer finds it optimal to increase the primary surplus by reducing expenditures rather than by increasing taxes: reducing expenditures

[13] In the Figure, $MCPF(b)$ intersects the origin, but it is not necessary to have $MCPF(0) = 0$. The actual level of $MCPF(0)$ is irrelevant for the analysis.

rather than raising taxes forces up disposable income and savings, and so it holds interest rates down.[14]

Proposition 5. *If* $\eta_1 = 0$ and $\Delta_1 = 0$**,** *then starting from any* b_0 *in a left neighborhood of a regular balanced growth path level, the growth rate in productivity* $\Delta z_t/z_t$ *gradually declines on the convergence path.*

Proposition 5 does not necessarily hold in the presence of learning-by-doing or private investment in human capital. The reason is that the tax rate may decline on the transition path. If this decline implies an increase in labor supply, then we have two forces pushing in opposite directions. A decline in the tax rate, however, does not generally imply that labor supply increases: As debt increases, agents hold more financial wealth. The wealth increase implies higher marginal utility of leisure, which may more than counterbalance the effect of the decrease in taxation.[15]

Finally, we note that the lower bound on lump-sum transfers always binds. Indeed, transfers are uniform across districts and, hence, are not subject to political conflict over the distribution of resources. Since taxation is distortionary, it is never optimal to tax citizens to redistribute the generated revenue back in the form of cash transfers.

4. A calibrated solution of the model

In this section we study the model presented above by numerical methods, calibrating it to the U.S. economy. Most of the parameter values we use are standard choices in the empirical macroeconomics literature. Those that are key to our approach – the parameters governing the legislative bargaining procedure and the externality parameter α – are chosen to minimize the differences between the model generated balanced growth path values of the

[14] To the contrary, an increase in taxes forces down disposable income and savings, and, hence, puts upward pressure on the interest rate.

[15] Similarly, when there is private investment into productivity, its output share increases along the transition path, potentially offsetting the decline in overall productivity.

fiscal variables and the corresponding average values in the U.S. in the 2001-10 period.[16]

Table 1 about here

We set μ to 1.37, which yields labor supply elasticity of about 1.5 on the model's balanced growth path. It is in a mid-range of the parameters used in the literature. We set δ to 0.954 - with 1.2% growth rate this implies an interest rate of 6% (Jaimovich and Rebelo, [2008]). The literature provides no guidance on the long-run elasticity of growth via learning-by-doing. We set $\eta_1 = 0.245$. That is, we assume that the long-run elasticity of the learning-by-doing with respect to labor is three quarters of its short run elasticity (Chang, Gomes and Schorfheide [2002]). η_0, ϕ_0, and Δ_0 are scale parameters and can be set to match the desired level of long-run growth. The transfer parameter, T, is set to its empirical counterpart, 10% of GDP.

The legislative bargaining parameters are n, $\mathcal{G}$, q, and $\underline{g}$. We normalize the number of districts to 100; we set the government size, $\mathcal{G}$, to 100, the majority required to pass the legislation, q, to 51, and lower bound on local public goods, $\underline{g}$, to .01: 1% of output of a single district. None of these parameters are particularly important in absolute terms, what matters is the factor $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)$. Our choices above imply that it is .02.[17] Recall, however, that the legislative bargaining alone does determine the long-run level of debt. The latter also depends on the externality parameter α. Ceteris paribus, the higher is α, the higher the steady state level of debt is. This relation is exploited in our calibration. In essence, we choose α to match the target value of the debt-to-GDP ratio.[18] More precisely, we choose α, ω, ϕ_1 and Δ_1 together to match the empirically observed (i) debt-to-GDP, (ii) public

[16] Implicit is the assumption that fiscal variables have been, on average, at their balanced growth levels during this time period. We note that choosing a different time period to construct empirical values of the fiscal variables, would result in qualitatively identical patterns to those described below. The data description is in the Appendix.

[17] Of course, there are alternative combinations of $\mathcal{G}$ and q that are consistent with this value of $\frac{\mathcal{G}}{n}Q(\mathcal{G},q)$. The behavior of the economy will be very similar under these alternatives.

[18] We note that different values of $\frac{\mathcal{G}}{n}Q(G,q)$ would change the implied value of α, but as long as there is political conflict, an increase in $\frac{\mathcal{G}}{n}Q(G,q)$ will simply translate into an increase in α and vice versa.

good-to-GDP, public investment-to-GDP, and private investment-to-GDP ratios (see Table 1). This yields values of 0.5225, 0.497, 0.0018 and 0.00083, respectively.

<<Figure 2 about here>>

Figure 2 describes the dynamics of the model. It shows the transition to the balanced growth path starting with no debt. A number of features of the equilibrium dynamics emerge. As predicted by our analytical results, debt grows faster than GDP, and public expenditure, as a fraction of GDP, declines. Taxes also decline during the transition. Hence, the shrinking government effect, discussed in Proposition 4, applies also to the revenue side. As debt increases, the government has to increase the primary surplus by either increasing taxes or reducing expenditures. Recall that reduction in expenditures increases citizens' savings and, hence, reduces the equilibrium interest rate. That is, by reducing expenditure the government relaxes the budget constraint both directly and indirectly, by reducing the equilibrium interest rate. The indirect effect of an increase in taxation is different. Higher taxes reduce disposable income and therefore, ceteris paribus, reduce savings and increase the equilibrium interest rate. As the stock of debt increases, the interest rate effect becomes increasingly significant, making tax increases even less attractive.

Despite the reduction in taxation, labor supply declines over time. This phenomenon is due to the fact that as debt increases, citizens hold more wealth: the wealth effect increases the marginal utility of leisure, and reduces labor supply. Productivity growth also declines as the economy converges to the balanced growth path. The decline in growth is due to two factors: the decrease in infrastructure investment by the government and the decrease in learning-by-doing triggered by the declining labor supply. In addition, the decline in labor supply offsets the rising share of private investment in GDP, countering its positive effect on productivity growth. Finally, the interest rate declines as the economy converges to the balanced growth path. This decline only partially reflects the falling growth rate of the

economy. It is mostly driven by the rise in debt. The higher is debt, the bigger the incentive to reduce spending and to manipulate the interest rate is.

4.1. Robustness

We next assess the robustness of the model's dynamics with respect to the parameter choices. We change one parameter at a time, keeping others at their benchmark values. In Table 2, for each parameter perturbation we report (i) its benchmark value, (ii) the magnitude and the direction of the change, (iii) the resulting long-run debt-to-GDP, public good-to-GDP, public investment-to-GDP, and private investment-to-GDP ratios. In addition, in the Appendix we provide figures that describe the dynamics of the economy starting from zero debt, just as Figure 2 does it for the benchmark case. In all of these cases, we find qualitatively the same patterns as in the benchmark case: the shrinking government effect, declining labor, declining productivity growth and a declining interest rate.

<<Table 2 about here>>

First (see first two rows), we change the discount factor. Naturally, the closer is the discount factor to one, the more the decision makers take the future into account and, consequently, the lower the long-run debt is.

Second (see third and forth rows), we change the parameter μ, which governs labor supply elasticity. The lower μ implies that the labor supply is less responsive to taxes, and hence it is less costly to "distort" future allocations, leading to more debt accumulation.

Third (see fifth row), we increase the growth elasticity with respect to private investment by tenfold. The purpose of such a dramatic increase is to see whether the decline in TFP growth that we saw in the benchmark calibration will also hold if the share of private investment were significantly larger. Naturally, we find that the balanced growth share of private investment increases dramatically, almost tenfold. Labor supply increases relative to the benchmark level. The fiscal policy variables are little affected.

Sixth and seventh rows report what happens if we dramatically decrease the share of public investment and the importance of learning-by-doing externality, respectively. Recall that both public investment and labor supply decline as the economy converges to the balanced growth path from below. Hence both of these forces drive the decline in TFP growth. Shutting them down allows us to assess how general the result about the declining TFP is. In both cases, the balanced growth debt-to-GDP ratio increases significantly. In the first case this follows from the fact that the decision makers are less concerned about providing public investment and can at the margin channel more resources to their own districts. In the second case, as the learning-by-doing externality disappears, it is less costly to tax labor, both contemporaneously and in the future. Consequently, taxation increases dramatically, labor supply falls, more public goods are provided, leading to a higher level of debt.

Eighth and ninth rows report changes implied by increasing/decreasing the weight of public goods in the citizens' utility. The long-run share of public goods changes with the parameter ω and so do the taxes. The long-run debt-to-GDP ratio moves in the opposite direction, suggesting that the more important pubic goods become, the less misaligned the preferences of legislators are.

The next two exercises concern the parameters governing the degree of political conflict, q and α. As we discussed previously, the larger is q – the majority needed to pass the allocation of public goods – the less is the degree of political conflict. We find that around our benchmark value of 51, the long-run debt-to-GDP ratio does not vary much with q. In fact increasing the majority from 51 to 71, implies only about a percentage point of GDP decrease in debt.[19] We also find that the long-run level of debt is much more responsive to the degree of public good externalities. As discussed earlier, the higher is α, the more self-interested the legislators become, pushing up the debt-to-GDP ratio. In fact, the highest

[19] Though, of course, when $q = 100$ debt collapses to zero.

value of α, at which an interior equilibrium exists is 0.61.[20] In the next section, we discuss in more detail how the long-run behavior of the economy changes with the parameter α.

Finally, we vary the amount of transfers, T. As the last two rows of Table 2 show, an increase in transfers is compensated both by higher taxes and lower public spending. There is more debt accumulation, suggesting that the legislators become more inclined to rely on future tax revenue to finance current expenditure.

4.2. Political conflict and long-run outcomes

We discuss in detail how the long-run predictions of the model change with the degree of the political conflict in the economy, as measured by the externality parameter α. Figure 3 illustrates the effect of changes in α from its benchmark value of 0.5225 in our calibration to 0 on the balanced growth path values of the variables of interest. As expected, a lower level of political conflict induces a lower long-run level of debt and a higher level of investment in public infrastructure and local public goods. Perhaps more surprisingly a decrease in political conflict induces an increase in the tax rate and it has a non-monotonic effect on labor supply. As α decreases, the tax rate increases to finance higher provision of public goods without increasing debt. As α decreases, labor supply initially increases. This phenomenon is due to the wealth effect: the decrease in α induces a decline in public debt and, hence, in privately held wealth, so it induces a decline in the marginal utility of leisure as well. For lower levels of α, however, the higher tax rate tends to counterbalance the wealth effect, and labor supply decreases in response to a decline in α. Nonetheless, the effects of taxation and wealth roughly offset each other–the differences in labor supply across different α's do not exceed 0.25 percent.

<<Figure 3 about here>>

[20] Above this value the debt-to-GDP ratio explodes, and the economy converges to its highest sustainable level of debt, public good provision collapses and tax rates increase to the peak of the Laffer curve.

The non-monotonicity in labor supply explains why, when α is low, the growth rate is slowly increasing with respect to α. Importantly, however, welfare is always increasing in α. Hence, the growth rate is not necessarily a good measure of welfare in this model. As political distortions are reduced, the public goods' share of output increases: public goods increase welfare, but they do not necessarily increase growth. That is, though the economy does not grow faster, it has a superior balance between the private and the public sector. Finally, since debt is monotonically decreasing in α, the non-monotonicity of the growth rate with respect to α may lead to a non-monotonic relation between debt and growth.

5. Growth and austerity programs

The political equilibrium is inefficient: It leads to an excessive accumulation of debt and may result in a subpar growth rate. We now ask whether (and how) welfare can be improved by changing the institutional setting. Two sets of variables are of interest: the political economy variables determining legislative bargaining, and "economic restraints" such as self-imposed constitutional constraints on deficit spending or debt limits.

Regarding the first set of variables, we have already discussed in the previous section the impact of changes in q. We note here that in our model even if within-each-period political conflict is eliminated (by imposing a unanimity rule or, equivalently, imposing a new rule that all districts must receive the same amount of public goods) the economy will not move to its Ramsey allocation. This is because the decision makers today cannot commit to the future policy choices since endogenous interest rates give rise to the standard time inconsistency problem. In fact, starting with a positive level of debt the Ramsey solution implies that the fiscal policy will be constant from next period onward, with some positive level of debt, while the egalitarian policymakers, without a commitment device, will slowly drive the debt level to zero. Nevertheless, we find that $q = 100$ is the optimal majority rule even if the economy starts at the level of debt twice the balanced growth level: The higher

q implies a better distribution of local public goods across districts. The implied expected welfare gains mute the short-term pain of higher taxes necessary to pay down the debt. In the long run, there is also a better balance between private and public expenditure.

To better understand the impact of self imposed constraints on deficit spending, we study here a simple class of austerity programs which are characterized by three features: the debt target, the number of periods allowed to reach the target and, finally, whether the target level shall be sustained forever or not (permanent versus temporary debt reduction). Effectively, we are capturing scenarios in which the legislature passes a law that establishes a new, lower, debt ceiling that goes into effect at a certain date in the future. Analyzing these scenarios may help to better understand the likely welfare impact of austerity measures like the Fiscal Compact in Europe or the Budget Control Act of 2011 in the U.S.

We consider two cases. First, the government can permanently commit to the debt ceiling. Second, the government can only commit to bring the debt below a certain level over a certain period of time. The second scenario is, perhaps, a more realistic description of situations in which a country is forced to adopt austerity measures as a pre-condition, .e.g., for international help.

Austerity with commitment. Suppose a country's debt is at its balanced growth path level. Consider the following type of austerity programs: the country is required to run a surplus to permanently reduce its debt by a certain fraction in T years.[21] Figure 4 illustrates the evolution of the equilibrium studied in the previous section when the economy is forced to reduce the level of debt relative to GDP by 50% of its current level in seven years, and keep it there forever. We consider this plan because, as we will show below, it is the optimal austerity plan for the economy with our benchmark parameter values.

[21] In particular we assume that the legislators are forced to reduce b by a constant amount in every period until the new target is reached. Note that here we define debt reduction in terms of b - that is the debt level (scaled by productivity). We do this to ease comparison with the robustness exercises that we report later. For the benchmark case we discuss below it is virtually identical to formulating the austerity program in terms of the reduction in the debt-to-GDP ratio.

<<Figure 4 about here >>

After the introduction of the program the tax rate and government expenditure in public goods and infrastructure spike up and down, respectively. There is, however, a key difference in their reaction: the tax rate keeps increasing for the entire period of the program and it settles at a permanently higher level; by contrast, public goods provision dips below the pre-program period level for two years, recovers afterwards and keeps increasing until the new balanced growth level is reached. In the seven years of the program, the tax rate increases by 4 percentage points and total public expenditure as a share of GDP increases by 5 percentage points.[22] During the austerity program, the growth rate of GDP remains below the pre-program level by about 0.5%. Since GDP growth declines, the debt-to-GDP ratio initially increases, but then it gradually falls until it reaches the target level.

Public investment, except for the initial dip, rises. Private investment shows exactly the opposite pattern. Overall productivity growth is low until the economy reaches its new balanced growth path. This is mostly due to the decline in labor during the transition process. The growth rate, however, is a poor measure of welfare and, hence, a poor way to measure the success of the program. The last panel of Figure 4 illustrates the dynamics of the per period expected indirect utility (augmented with future utility gains stemming from current investment decisions and learning-by-doing). This welfare measure falls and remains below the pre-austerity level during the duration of the programs. Once the target level of debt is reached, it is permanently higher than the pre-austerity level.

An important feature of the transition is that although the program imposes to run a fiscal surplus, the size of the public sector over GDP increases over time. This is the *shrinking government effect* in reverse. As the debt declines, so do the reasons to manipulate the interest rates. This, in turn, reduces the pressure to keep expenditure and taxes low. Consequently, the economy gears to a better policy mix and, through it, a better balance

[22] The latter rises more than the former because the government has to pay less interest on debt after the change.

between the private and the public sectors.

The optimal austerity plan with commitment. Table 3 compares the welfare effects of alternative austerity programs for the benchmark calibration. The rows of the table list alternative target reductions in the debt. The columns of the table list alternative horizons of the program. The entry x_{ij} in column i and row j is the equivalence variation associated to the austerity program expressed as a percentage of consumption in each period.[23] Two findings are noteworthy. First, except for extremely ambitious programs (both in terms of debt reduction and/or in terms of time horizon), austerity is welfare improving. Second, the effect of a program is neither monotonic in its size nor in its time horizon. If, for example, we fix the time horizon at $T = 7$ periods, austerity implies a gain of 0.83% in per period consumption for the target level of 135% of GDP; as we reduce the target to 20% of GDP, the benefit increases to 2.19%; but for targets below 20%, the benefit declines, reaching a negative value of -1.75% for the complete elimination of debt. Similarly, if we target a debt reduction of 50%, achieving the goal in one period is equivalent to a *permanent* reduction in consumption of -2.69%; achieving it in 7 periods induces a permanent increase in consumption by 2.19%; achieving it in 20 years induces an increase by 1.91%.

<<Table 3 about here >>

The fact that an austerity program forcing fast debt repayment improves welfare may appear surprising at first sight. Although the debt level is inefficiently high at the equilibrium balanced growth path, it may appear that the best way to pay it back is just to evenly spread its cost over time by servicing its cost and keeping the principal constant. We note, however, that although at the balanced growth path the legislators keep policies constant, the policy mix is inefficient. The lack of commitment induces legislators to use fiscal policy to influence

[23] In particular, let c_t, l_t, γ_t and $\widehat{c}_t$, $\widehat{l}_t$, $\widehat{\gamma}_t$ be the path of consumption, labor and public goods provided before and after austerity program ij implemented at t_0. The variable x_{ij} is is chosen so that $\sum_{t=t_0}^{\infty} \delta^t \left[u(c_t(1+x_{ij}), l_t, \gamma_t)\right]$ is equal to $\sum_{t=t_0}^{\infty} \delta^t u(\widehat{c}_t, \widehat{l}_t, \widehat{\gamma}_t)$.

the interest rate. Forcing legislators to run a primary surplus is not directly beneficial because it reduces public debt; it is beneficial because it induces them to change the policy mix. To show this we compare the equilibrium b^* with the one that would be reached by a benevolent planner with commitment (the first best) and with the balanced growth level reached after the austerity plan, in both cases starting from $b_0 = b^*$. The benevolent planner would increase the tax rate from 21% to 35%, and public goods from 9% to 23%. Imposing the austerity plan at b^* does not induce such a large long-term change in the policy mix, but it brings it closer to optimal levels, inducing levels of 25% and 14%, respectively.

<<Table 4 about here >>

How does the design of the optimal austerity program depend on the level of debt before the plan is implemented? In the benchmark calibration presented above the parameters are chosen so that the balanced growth level of the debt-to-GDP ratio is 40.4%. Table 4 presents optimal austerity for each set of parameters considered in the robustness section. The first five columns are from Table 3. The last two columns describe the associated optimal austerity program. Table 4 illustrates that there is no "one-size-fits-all" optimal austerity program. For example, as α increases, and therefore debt relative to GDP increases as well, the time horizon of the optimal program becomes longer and the target level less demanding.

Austerity with limited commitment. The assumption that the austerity plan can impose a permanent reduction in debt is, perhaps, extreme. Below we assume that austerity can be imposed only for a limited period of time, after which legislators are free to choose policies with no constraints. Figure 5 illustrates the effect of reducing debt by 50% in 7 years; at the end of the 7th year the program is terminated and so legislators return to the political equilibrium.[24] Naturally, the program induces only a temporary effect on policies. After the end of the program, the economy converges back to the (inefficient) balanced growth

[24] We assume that the length of the program is rationally anticipated by the legislators, who therefore take into account the temporary nature of the program in choosing the policies.

path. Table 5 illustrates the welfare effects of alternative austerity programs of this type. As expected, the welfare gains from temporary austerity measures are lower than those from corresponding permanent ones, and, in fact, are all negative. Moreover, the shorter is the program duration, the larger is the welfare loss induced by it.

<<Figure 5 about here >>

<<Table 5 about here>>

6. Conclusion

We developed a political economy theory of growth and fiscal policy. The growth rate depends on public investment, private investment in human capital and, through learning-by-doing, labor supply. Policy choices are made by a legislature consisting of elected representatives. Political conflict arises because representatives in the legislature have incentives to vote for policies that favor their own constituencies and citizens benefit only partially from local public goods provided to constituencies to which they do not belong.

The model predicts that the economy converges to a balanced growth path. The transition to the balanced growth path is characterized by what we call the *shrinking government effect*: public debt grows faster than GDP, provisions of public goods and infrastructure grow slower than GDP and the tax rate declines.

We use the model as a laboratory to study the impact of austerity programs in which a country is required to bring down its debt-to-GDP ratio. We show that austerity programs may be used to limit political distortions and increase welfare.

References

Aguiar, M. and M. Amador, 2011. "Growth under the Shadow of Expropriation," *Quarterly Journal of Economics.* 126(2), pp. 651-697.

Aguiar, M. and M. Amador, 2012. "Policy in Debt-Constrained Economies," Mimeo.

Aiyagari, R., A. Marcet, A., T. J. Sargent, and J. Seppala, 2002. "Optimal Taxation without State-Contingent Debt," *Journal of Political Economy* 110, pp. 1220–1254.

Alesina, A. and D. Rodrik, 1994. "Distributive Politics and Economic Growth," *Quarterly Journal of Economics*, 109(2), pp. 465-90.

Alesina, A. and G. Tabellini, 1990. "A Positive Theory of Fiscal Deficits and Government Debt," *Review of Economic Studies* 57, pp. 403-414.

Alesina, A., R. Perotti and J. Tavares, 1998. "The Political Economy of Fiscal Adjustments," *Brookings Papers on Economic Activity*, 29(1), pp. 197-266.

Ardagna, S., 2004. "Fiscal Stabilizations: When Do They Work and Why," *European Economic Review*, 48(5), pp. 1047-1074.

Azzimonti, M., M. Battaglini and S. Coate, 2011. "Analyzing the Case for a Balanced Budget Amendment to the U.S. Constitution," Mimeo.

Barro, R. J., 1979. "On the Determination of the Public Debt," *Journal of Political Economy*, 87, 940-971.

Battaglini, M., 2014, "A Dynamic Theory of Electoral Competition," *Theoretical Economics*, 9, pp. 515-554.

Battaglini, M., and S. Coate, 2008. "A Dynamic Theory of Public Spending, Taxation and Debt." *American Economic Review*, 98, pp. 201-36.

Battaglini, M. and S. Coate, 2014. "Fiscal Policy and Unemployment," *Journal of the European Economic Association, forthcoming.*

Bertola, G. 1993. "Factor Shares and Savings in Endogenous Growth," *American Economic Review*, 83(5) , pp. 1184-1198.

Chang, Y., J. F. Gomes and F. Schorfheide, 2002. "Learning-by-Doing as a Propagation Mechanism," *American Economic Review,* 92(5), pp. 1498-1520.

De Bortoli, D. and F. Nunes, 2013. "Lack of Commitment and the Level of Debt," *Journal of the European Economic Association*, 11 (5), pp. 1053-78.

Jaimovich, N. and S. T. Rebelo, 2008. "Can News about the Future Drive the Business Cycle?" *American Economic Review,* 99, pp. 1097-1118.

Jaimovich, N. and S. T. Rebelo, 2013. "Don't Cross the Line: Non-Linear Effects of Taxation on Growth," Mimeo.

Krusell, P. and J.-V. Rios-Rull, 1999. "On the Size of U.S. Government: Political Economy in the Neoclassical Growth Model," *American Economic Review*, 89(5), pp. 1156-1181.

Martin, F., 2009. "A positive theory of government debt," *Review of Economic Dynamics*, 12 (4), pp. 608–631.

Occhino, F., 2012. "Government Debt Dynamics Under Discretion," *The B.E. Journal of Macroeconomics,* 12, Iss. 1.

Perotti, R., 1993. "Political Equilibrium, Income Distribution, and Growth," *Review of Economic Studies*, 60(4), pp. 755-76.

Persson, T. and S. Svensson. 1989. "Why a Stubborn Conservative Would Run a Deficit: Policy with Time-Inconsistent Preferences," *Quarterly Journal of Economics*, 104:325-346.

Rebelo, S. T., 1991. "Long-Run Policy Analysis and Long-Run Growth," *Journal of Political Economy*, 99(3): pp. 500-521.

Saint-Paul, G. and T. Verdier, 1993. "Education, democracy and growth," *Journal of Development Economics*, 42(2), pp. 399-407.

Stokey, N. L. and R. E. Lucas, Jr., 1983. "Optimal Fiscal and Monetary Policy in an Economy without Capital," *Journal of Monetary Economics,* 12, pp. 55-93.

Stokey, N. L. and S. T. Rebelo, 1995. "Growth Effects of Flat-Rate Taxes," *Journal of Political Economy*, University of Chicago Press, 103(3), pp. 519-50.

	$\frac{\text{Federal Debt}}{\text{GDP}}$	$\frac{\text{Public Goods}}{\text{GDP}}$	$\frac{\text{Public Investment}}{\text{GDP}}$	$\frac{\text{Private Investment}}{\text{GDP}}$
Data	40.4	9.4	0.9	1.5
Model	40.4	9.4	0.9	1.5

Table 1. Calibration.

Targeted and model generated steady state values of fiscal variables and private investment.

Parameter				S.S. $\frac{\text{debt}}{\text{GDP}}$	S.S. $\frac{\text{public G.}}{\text{GDP}}$	S.S. $\frac{\text{public I.}}{\text{GDP}}$	S.S. $\frac{\text{private I.}}{\text{GDP}}$	S.S. taxes	S.S. labor	S.S. growth
	Role	Value	Change							
δ	discount	0.954	+ .02	26.1	9.8	1.6	2.7	20.4	101.7	0.5
	factor		– .02	58.3	7.9	0.5	1.0	21.7	98.3	-0.6
μ	labor	1.37	x 2	39	7.9	0.7	1.5	19.7	62.0	-11.8
	supply		: 2	44.1	11.6	1.1	1.5	23.6	143.3	8.9
Δ_1	private I.	$8.3{\cdot}10^{-4}$	x 10	52	8.4	0.8	13.1	20.6	108.3	
η_1	public I.	$1.8{\cdot}10^{-3}$	: 10	59.8	6.0	0.0	1.5	18.7	99.6	
ϕ_1	LBD	0.245	: 10	77.9	12.7	1.2	1.4	26.2	98.3	
ω	public G.	0.497	+ .20	34.4	12.4	1.0	1.5	24.0	100.0	0.0
	provision		– .20	55.1	5.5	0.7	1.6	18	99.7	-0.1
q	majority	51	+ 20	39.3	9.7	0.9	1.5	21.5	100.0	0.0
			– 20	41.0	9.3	0.9	1.5	21.2	100.0	0.0
α	public g.	0.5225	+ .08	73.4	5.0	0.4	1.6	18.3	99.3	-0.3
	externality		– .08	28.2	12	1.2	1.3	23.3	100.2	0.1
T	social sec.	10	+ 5	51.3	6.5	0.6	1.5	28.9	96.1	-1.1
	transfers		– 5	31.5	13.0	1.3	1.4	14.4	103.9	1.0

Table 2. Robustness.[25]

Model generated steady state values of fiscal variables and private investment under alternative calibrations.

[25] For the experiments regarding η_1, ϕ_1 and η_1 we do not report the changes in productivity growth, as the changes in these parameters change the nature of the growth process and, hence, do not allow for meaningful comparisons.

Cut	Target	Duration										
in b,%	$\frac{\text{debt}}{\text{GDP}}$	1	2	3	4	5	6	7	8	9	10	20
12.5	35	0.53	0.81	0.84	0.85	0.85	0.84	0.83	0.81	0.80	0.79	0.65
25	30	0.52	1.36	1.46	1.50	1.51	1.5	1.49	1.47	1.45	1.43	1.20
37.5	25	-0.31	1.59	1.83	1.93	1.96	1.97	1.96	1.94	1.92	1.90	1.63
50	20	-2.68	1.44	1.88	2.06	2.14	2.18	2.19	2.19	2.18	2.16	1.91
62.5	15		0.78	1.52	1.82	1.97	2.05	2.10	2.12	2.14	2.14	2.00
75	10		-0.55	0.60	1.08	1.33	1.48	1.58	1.65	1.70	1.74	1.81
87.5	5		-2.85	-1.11	-0.40	-0.01	0.24	0.43	0.57	0.68	0.77	1.24
100	0		-6.69	-4.11	-3.07	-2.47	-2.06	-1.75	-1.50	-1.28	-1.09	0.06

Table 3. Long-term austerity programs.

Each entry reports the welfare gains or losses associated with an austerity program with a duration in the column header and a targeted debt reduction in the row header.[26]

[26]No entry implies that the austerity program is not feasible.

Parameter				S.S.	Optimal Austerity	
	Role	Value	Change	$\frac{\text{debt}}{\text{GDP}}$	years	% reduction
δ	discount	0.954	+ .02	26.1	7	62.5
	factor		– .02	58.3	8	50
μ	labor	1.37	x 2	39	8	50
	supply		: 2	44.1	8	62.5
Δ_1	private I.	$8.3{\cdot}10^{-4}$	x 10	52	8	62.5
η_1	public I.	$1.8{\cdot}10^{-3}$	: 10	59.8	10	62.5
ϕ_1	LBD	0.245	: 10	77.9	6	37.5
ω	public G.	0.497	+ .20	34.4	7	62.5
	provision		– .20	55.1	10	62.5
q	majority	51	+ 20	39.3	7	50
			– 20	41.0	8	50
α	public g.	0.5225	+ .08	73.4	10	62.5
	externality		– .08	28.2	7	50
T	social sec.	10	+ 5	51.3	10	62.5
	transfers		– 5	31.5	7	50

Table 4. Optimal austerity measures for alternative calibrations.

Cut	Target	Duration						
in b,%	$\frac{\text{debt}}{\text{GDP}}$	1	2	3	4	5	6	7
12.5	35	-1.55	-1.17	-1.05	-0.96	-0.88	-0.80	-0.74
25	30	-3.52	-2.47	-2.19	-1.98	-1.81	-1.67	-1.53
37.5	25	-6.13	-3.91	-3.42	-3.08	-2.81	-2.58	-2.38
50	20	-10.1	-5.49	-4.73	-4.24	-3.87	-3.56	-3.28
62.5	15		-7.25	-6.15	-5.48	-5.00	-4.59	-4.24
75	10		-9.23	-7.68	-6.82	-6.20	-5.7	-5.27
87.5	5		-11.5	-9.35	-8.26	-7.50	-6.9	-6.39
100	0		-14.1	-11.2	-9.84	-.8.93	-8.22	-7.63

Table 5.

Short term austerity programs. Each entry reports the welfare gains or losses associated with an austerity program with a duration in the column header and a targeted debt reduction in the row header.[27]

[27]No entry implies that the austerity program is not feasible.

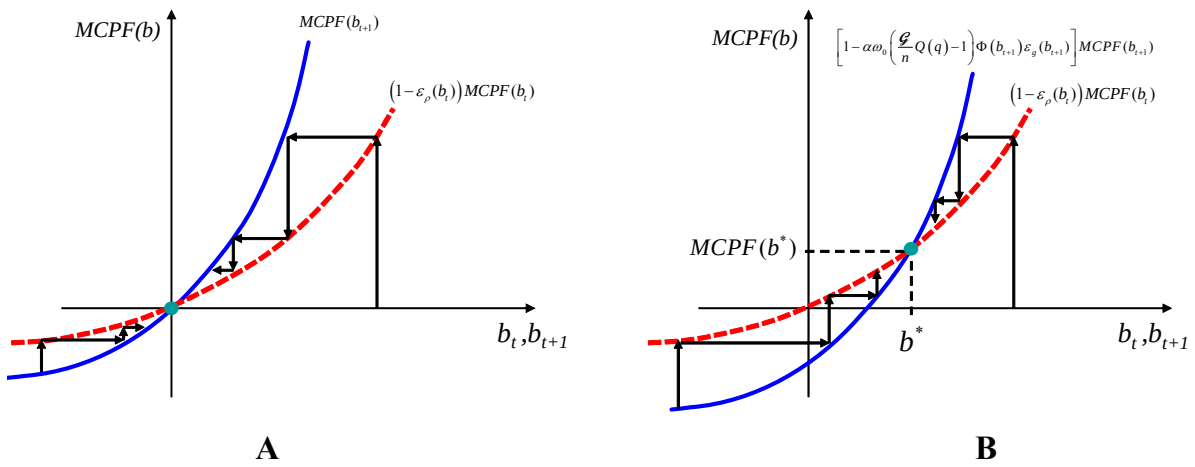

Figure 1: The Euler equation for $\mathcal{G} = q = n$ and $q < n$.

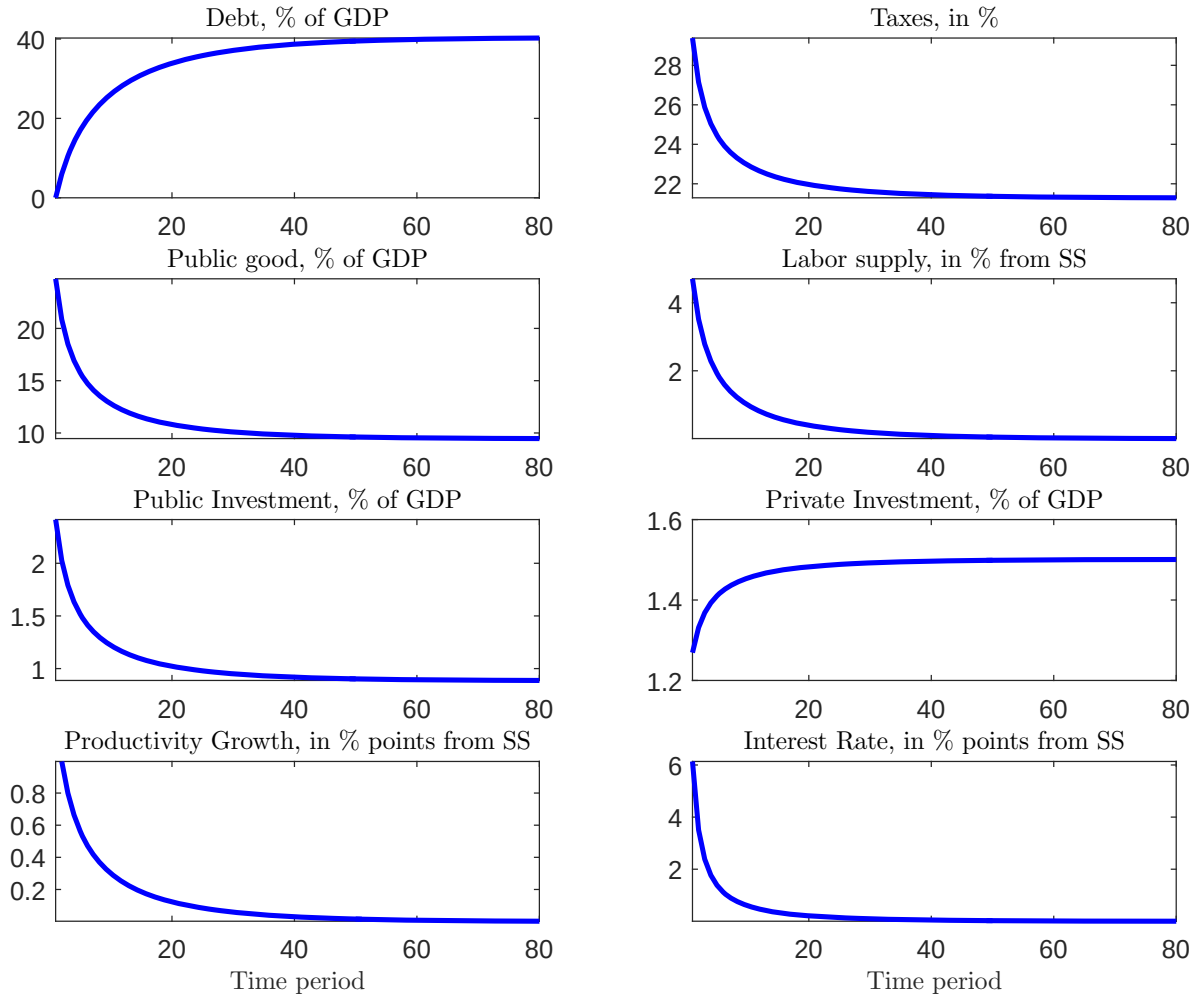

Figure 2: Dynamics starting with zero debt.

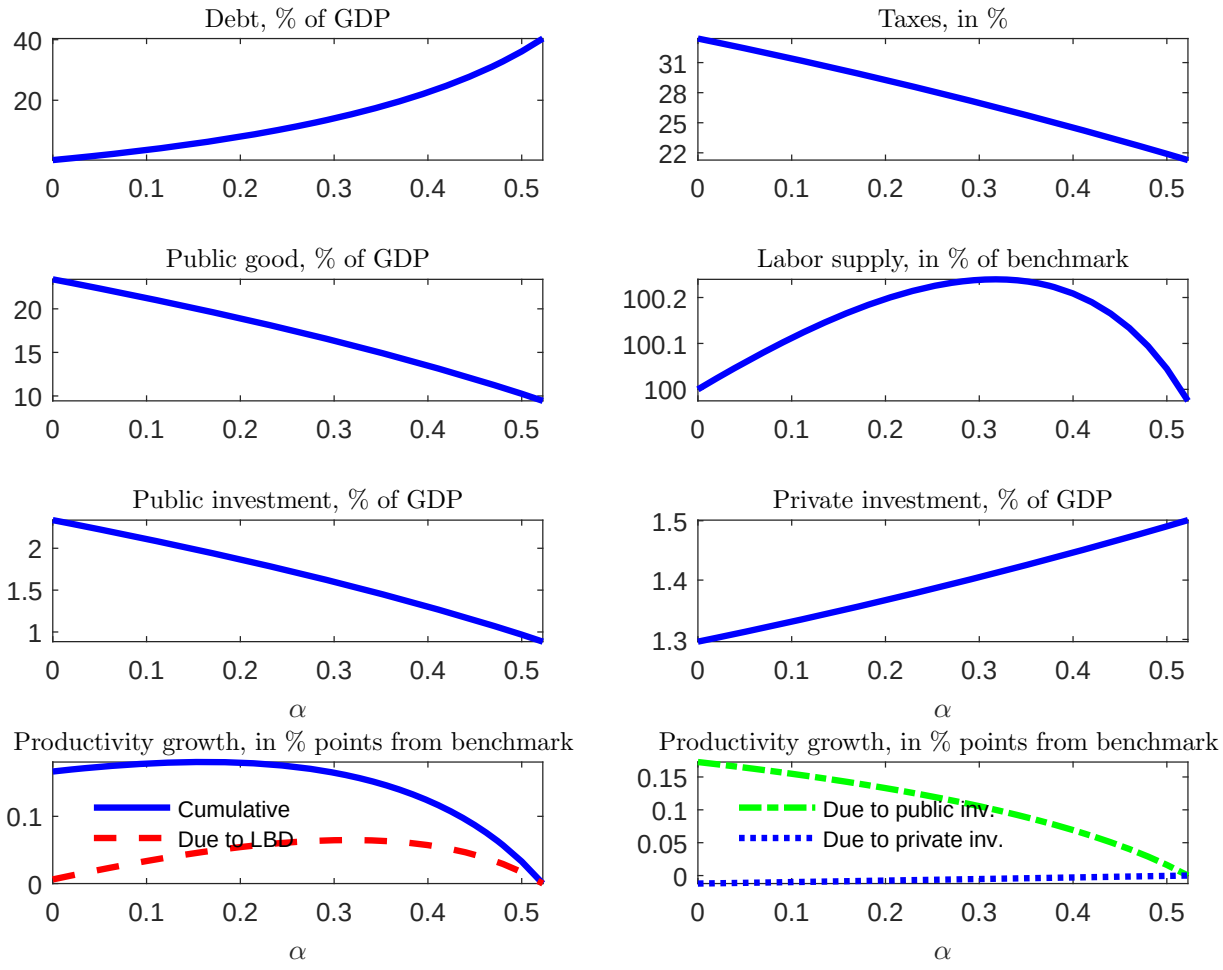

Figure 3: Political Conflict, Fiscal Policy and Economic Outcomes.

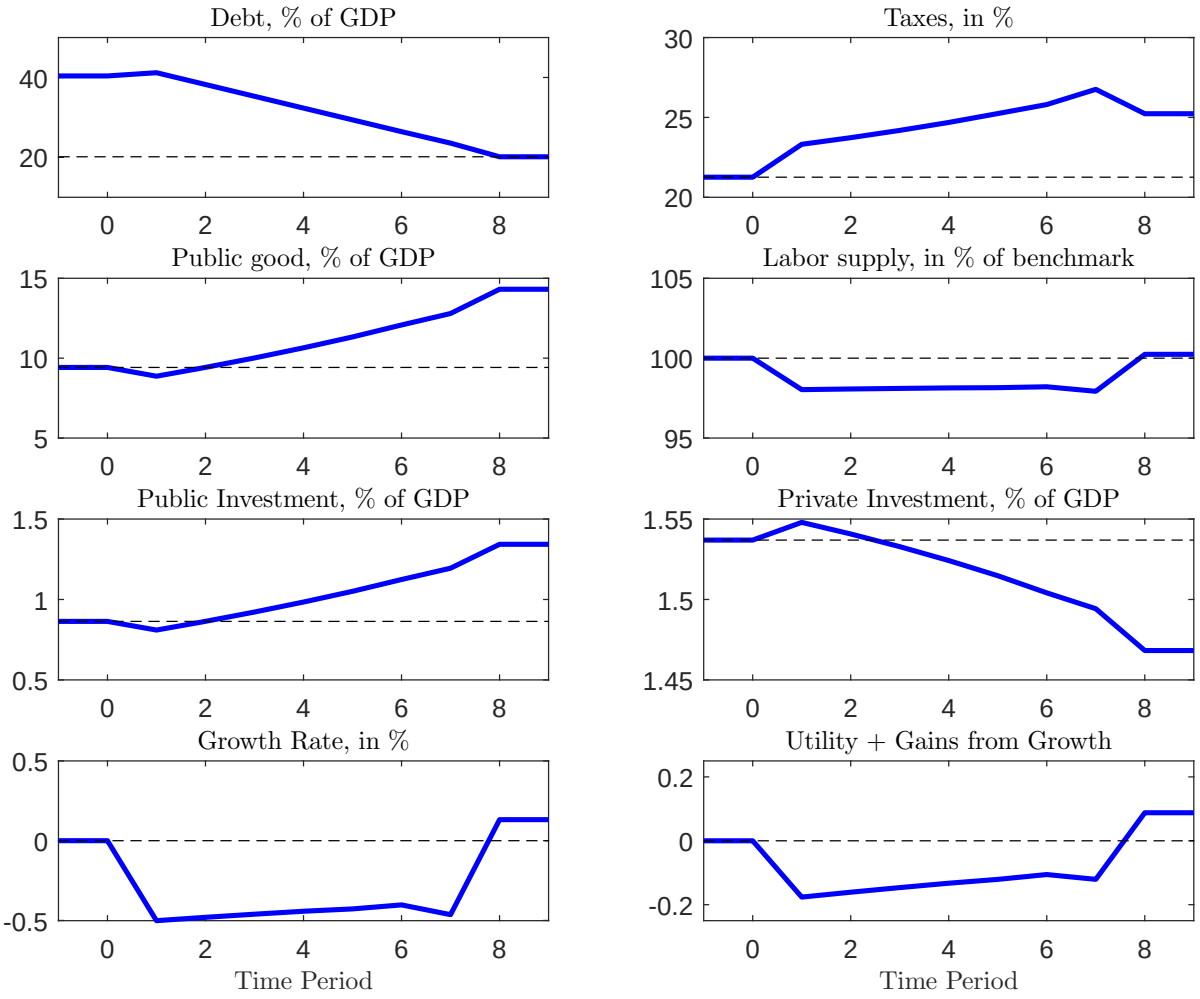

Figure 4: Evolution of the economy during the optimal austerity program.

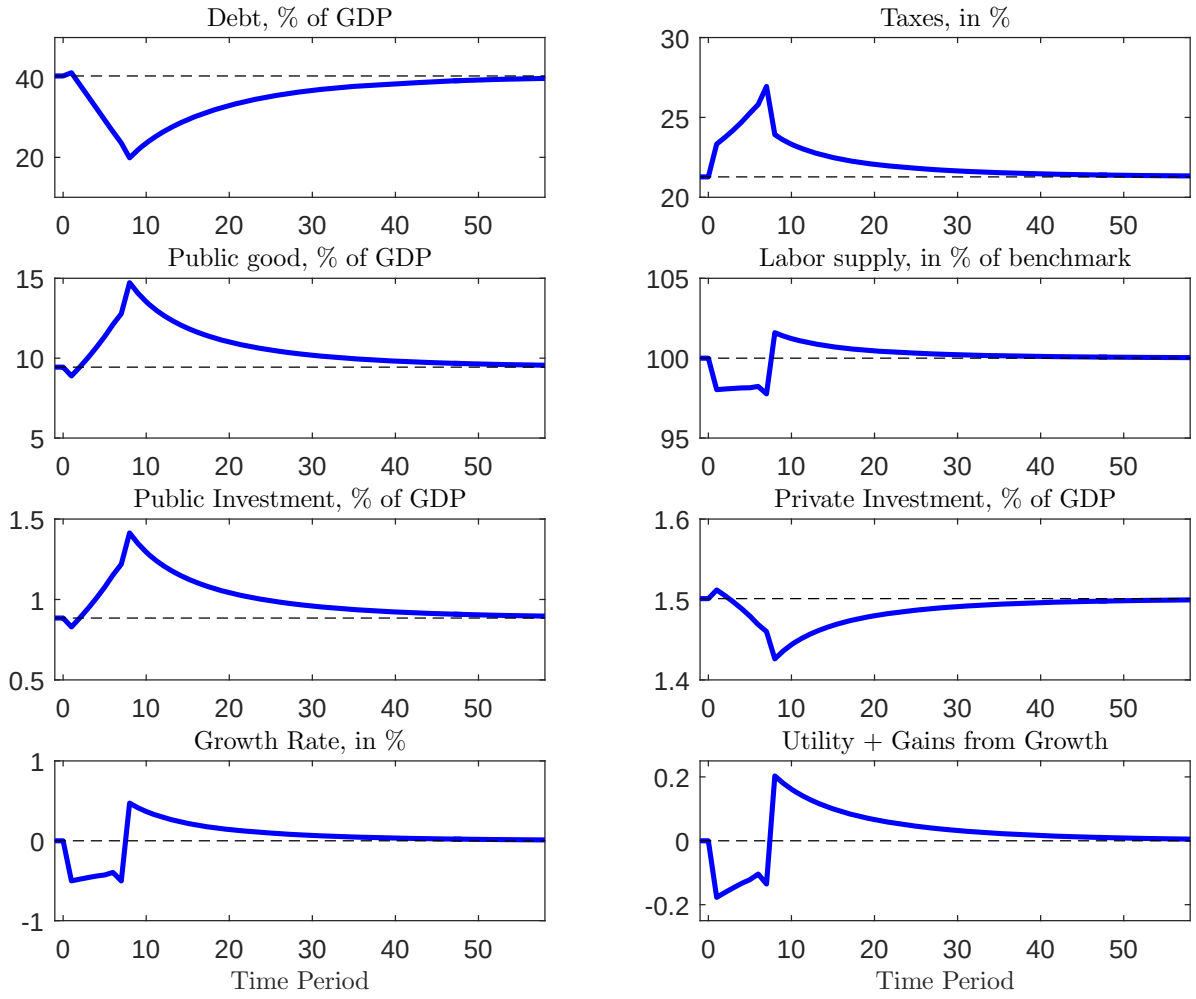

Figure 5: Evolution of the economy during a temporary austerity program.